

Towards Education 4.0: Analysis of the Digital Tools Used by Uzbek University Teachers

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Abstract—The practical application of digitalization in higher education through contemporary digital tools is gradually moving towards Education 4.0. Along with the achievements in this process, there are problems related to technological and human factors. One of the teachers' problems is utilizing new digital instruments. This work aims to identify digital tools that university professors use in the Republic of Uzbekistan. The data collection tool was an online questionnaire developed using Google Forms. The sample comprised 77 teachers from 13 universities in the capital city and five provinces. Statistical methods describing frequencies in percentages were used to analyze the data. Analysis of results showed that Uzbek university professors use open cloud-based tools and resources based on artificial intelligence; more than half of professors need motivation and practical support. This research provides recommendations for creating a repository of digital tools for gamification and visualization, VR/AR and Big Data Analytics; developing training to support academic staff in exploring new digital resources for Education 4.0.

Keywords—higher education, academic staff, teaching and learning, digital tools, Education 4.0

I. INTRODUCTION

The practical application of digitalization in the Higher Education system with modern digital tools is gradually moving towards Education 4.0, which aims to create a digital educational environment that ensures continuity, personalization, mobility, interaction, and flexibility of learning [1].

The Government of the Republic of Uzbekistan has adopted the conceptual approach to the digitalization process, which is reflected in the “The Action Strategy for the five priority areas of development of the Republic of Uzbekistan for 2017–2021”, “New Uzbekistan Development Strategy 2022–2026”, and the National Strategy “Digital Uzbekistan – 2030” [2]. These decrees pay great attention to the digitalization of Higher Education because this system trains highly qualified and in-demand specialists for the digital economy.

The tasks set by the Government of the Republic of Uzbekistan are implemented in the form of innovative solutions both in Higher Education programs [3] and in the system of continuous professional development of national personnel based on the introduction of distance learning platforms and online courses [4], improved advanced training courses for academic staff [5] and pedagogical staff's electronic portfolios [6, 7].

Along with achievements in the digitalization of education, some problems are associated with both technological solutions and the human factor. One of the problems is the

need for academic staff to develop skills in using new digital tools, which slows down the process of transition to Education 4.0.

Amhag *et al.* [8] discovered that assuming digital tools is often hampered by teachers' undersupply of the essential skills to use the tools entirely in the digital environment. Also, they noted that, despite the many digital resources, programs, and opportunities for digitalization of the educational process, the academic staff remains vital for effective learning.

In this regard, it is interesting to study the digital tools that Uzbek University teachers use and do not use to help them move toward Education 4.0.

This work aims to identify digital tools university professors use in the Republic of Uzbekistan to help them advance towards Education 4.0.

Against this background, the following tasks are asked:

- 1: To identify a list of digital tools of Education 4.0 established from the current literature review.
- 2: To determine the digital tools that Uzbek University academic staff uses for teaching and learning based on an online questionnaire.
- 3: To offer recommendations founded on comparing professors' digital tools at Uzbek universities and digital tools of Education 4.0.

II. LITERATURE REVIEW

In the last few years, researchers have actively studied the concept of Education 4.0.

It has been analyzed how the evolution of the technology industry has affected education over time, from traditional learning to innovative education through computerization, informatization, and digitalization [9].

Huk [10] analyzed the historiography of the problem of using educational tools for Education 1.0, Education 2.0, Education 3.0, and Education 4.0 was carried out. It is shown that the concept of Education 4.0 represents an entirely new approach to learning, meeting the challenges of the digital revolution and aiming to transform the future.

Education 4.0 through the use of the Internet of Things, Big Data processing with the application of Data Science and Data Analytics [11], Artificial Intelligence (AI) [12], Machine Learning [13], Cloud Computing [14], and Virtual Reality processing [15] for virtual and experimental environments allows educators to create the digital learning environment to improve the pedagogical procedures of Higher Education [16].

These technological advances, combined with innovative approaches, will enable them to address the educational

needs of each student and pedagogical problems mainly related to digital applications and the digital environment [17].

Gajek *et al.* [18] showed that one of the critical points of Education 4.0 is the issue of ensuring security in the era of Industry 4.0, defined as Safety 4.0.

Miranda [19] defined Education 4.0 as the current period in which Higher Education institutions apply new learning methods, innovative didactic and management tools, smart and sustainable infrastructure mainly complemented by emerging information and communication technologies to improve knowledge generation and information transfer processes.

There were four components of Education 4.0:

- Competence (professional competence and 4C-competencies);
- Learning methods and tools (game-based learning and collaborative learning);
- Technologies, tools and platforms (digital resources, cloud storage, visualization, and virtualization);
- Infrastructure (digital educational environment).

Akimov *et al.* [20] presented a systematic review of 48 Web of Science and Scopus studies, which allowed us to identify the main components of Education 4.0 too:

- Competence (“soft” skills and “hard” skills, 4C-competences);
- Learning and teaching strategies (knowledge, skills, character, meta-learning);
- Technologies (digital tools and on-line resources, software, applications, and digital platforms);
- Infrastructure (digital environment);
- Stakeholders (fostering platforms, active communication and collaboration among key stakeholders).

Based on the research analysis of the problem under study, we can identify digital tools as one of the most essential components of the Education 4.0 concept.

Digital tools are software or hardware used to work with digital information, process data, create content, interact with digital technologies, and solve various problems in the digital environment.

Goldin *et al.* [21] summarized digital tools of Education 4.0. These were the important ones:

– LMS, video conferencing, digital exam assessment, data exchange and cloud systems, collaboration, game-based learning, digital library and database, virtual and remote lab, digital white/chalkboard, and digital grade book tools.

Robinson *et al.* [22] identified innovative technologies that have emerged since 2000 and offered a list of digital tools for learning and communication:

– LMS, website services and storage, smart mobile devices and apps, collaborative productivity software, multimedia sharing, and social media.

Zheng *et al.* [23] showed that game-based learning has demonstrated potential for improving student learning, motivation, and engagement in the digitalization.

Summarizing the studies presented above, we have classified digital tools of Education 4.0 using innovative teaching and learning methods, as shown in Fig. 1.

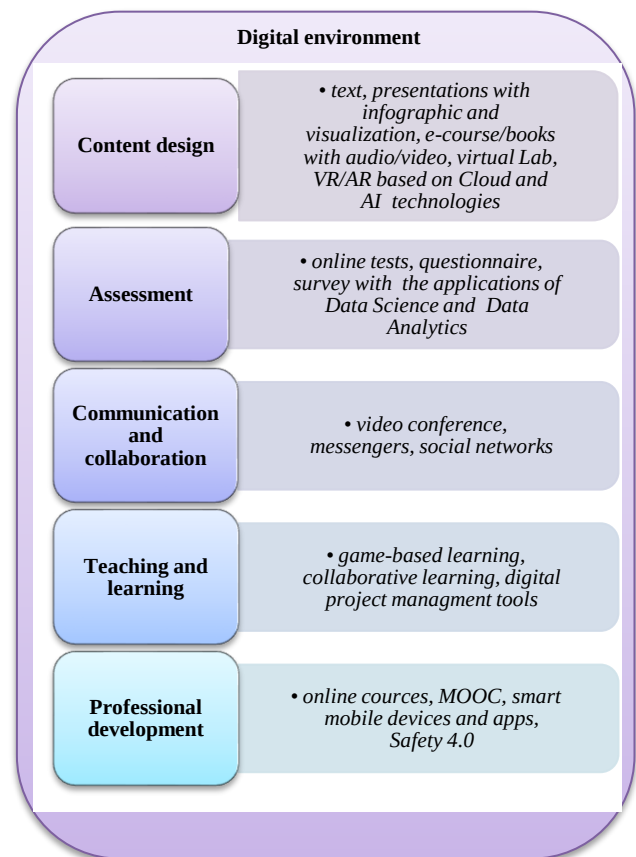


Fig. 1. Digital tools of Education 4.0.

III. MATERIALS AND METHODS

A. Methods and Scale

Online questionnaires have recently become increasingly popular among academics, particularly since the coronavirus pandemic. Therefore, an online questionnaire was used to identify digital tools.

The first part of the online questionnaire was used to collect demographic information about the respondents.

The second part of the online questionnaire was used to identify the principal digital tools Uzbek University teachers use for educational purposes. The online questionnaire consisted of ten questions in six sections corresponding to Fig. 1.

The first section examines the dominant types of pedagogical activity in using digital tools. This question (question 1: What purposes do you use digital tools for?) was open-ended because respondents will be able to think about and describe their actions in the digital space.

To identify the digital tools that university teachers use for educational content creation in various forms, multiple-choice questions were designed with the option to indicate their answer choice:

- Instructional text (question 2: What digital tools do you use to design instruction text for students?);
- Presentations (question 3: What digital tools do you use to design presentation for students?);
- Infographic (question 4: What digital tools do you use to create an infographic?);
- Visualization (question 5: What digital tools do you use to visualization?);

- Electronic/online courses (question 6: What digital tools do you use to create electronic/online courses?).

To determine the list of digital tools that university professors use for assessment (question 7: What digital tools do you use to assess students?), a multiple-choice question was compiled with the opportunity to indicate answers.

One question was designed to identify the digital tools university faculties use for communication and collaboration (question 8: What digital tools do you use for communication and collaboration?).

A multiple-choice question was designed to explore the digital tools that professors use to facilitate gamification (question 9: What digital tools do you use to organize gamification in teaching?).

To determine the digital tools university teachers use for professional development, a closed question was drawn about attitudes toward teaching innovative technologies (question 10: Will you explore new digital tools to organize digital education?). The response format for this question was a five-point scale: 1 “no,” 2 “no because they are useless,” 3 “If someone teaches me, I will use,” 4 “If I know about their effectiveness, I will learn,” 5 “I always learn on my own.”

B. Data Collection

The data collection tool within this study was an online questionnaire. Data were collected through an online questionnaire completed voluntarily by professors from 13 universities in the Republic of Uzbekistan. All participants were informed of the study’s aim, and their anonymity was guaranteed. University faculties were asked to answer an online questionnaire implemented using Google Forms survey tools. The link to the online survey was distributed through telegram channels of training courses of the Branch Center for Retraining and Advanced Training of Pedagogical Staff under the Tashkent University of Information Technologies named after Muhammad al-Khwarizmi.

C. Sample

Data from 83 respondents were analyzed in this study. In the data cleaning process, we excluded 6 respondents from the sample because these participants did not answer all the questions. Thus, the final sample consisted of 77 respondents. These professors were from technical universities in the Republic of Uzbekistan, including 40 teachers (51.95%) from seven universities in Tashkent and 37 faculties (48.05%) from six universities in Samarkand (20.78%), Andijan (2.6%), Jizzak (3.9%), Namangan (18.18%), and Navoi (2.6%) Provinces. There were professors from the Computer Science (20.78%), Computer Engineering (10.39%), Software Engineering (11.69%), Telecommunication Engineering (9.09%), Education (20.78%), E-library (5.19%), and Social Sciences (5.19%) departments. Among the participants, 50.65% were women ($n = 39$), and 49.35% were men ($n = 38$). Most participants worked as assistant professors and senior (54.54%), and about half were associate professors and professors (45.45%).

D. Data Analysis

The online questionnaire data were processed using Microsoft Excel. Statistical methods describing frequencies in percentages and central tendencies were used to analyze the data.

IV. RESULT

The development of digital technologies, which results in the active digitalization transformation of Higher Education, implies an increase in the level of professional involvement of professors in the digital educational space. Fig. 2 shows the professional involvement (question 1) of Uzbek University teachers (please note that respondents could select multiple digital tools).

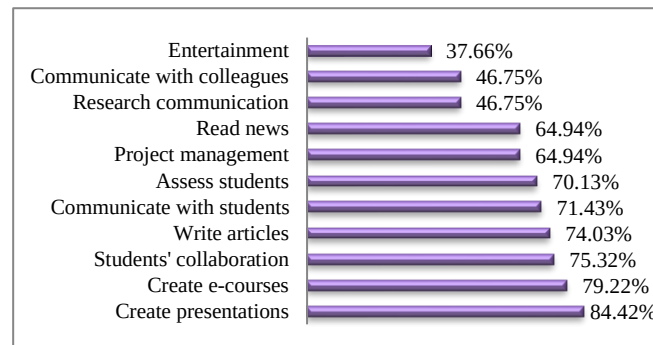


Fig. 2. Professional engagement bar diagram.

Respondents actively use digital tools for teaching and research purposes. Moreover, most are not just users but developers of presentations (84.42%) and creators of interactive electronic courses or online courses (79.22%). It can also be noted that the majority of respondents actively organize educational collaborations (75.32%) and research collaborations (46.75%). At the same time, respondents organize student collaborations almost twice as often as research collaborations. These results indicate that respondents are actively moving towards Education 4.0, characterized by interactive and collaborative teaching and learning methods.

An analysis of respondents’ answers to questions related to the creation of educational content in the form of text, presentation, infographics, visualization, electronic or online courses (questions 2–6) is presented in Fig. 3.

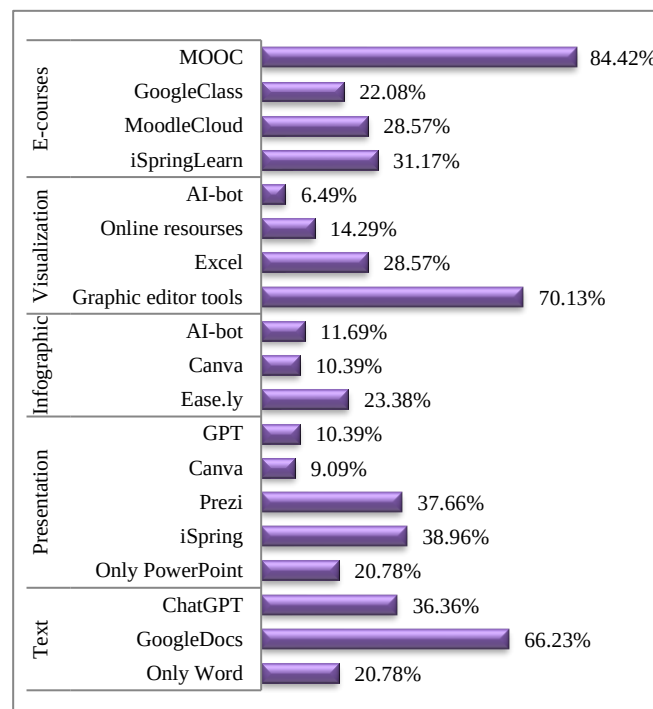


Fig. 3. Bar diagram of digital tools used by respondents for design content.

Fig. 3 shows:

- 81.82% of respondents use distance learning portals, such as GoogleClass (22.08%), iSpringLearn (31.17%), and MoodleCloud (28.57%), which reveals the respondents' skills in the field of automation of learning and management of student competencies;
- 84.42% of respondents use open educational resources based on MOOCs, which indicates the use of an inclusive and accessible ecosystem for knowledge sharing;
- The majority of respondents use educational resources based on cloud services such as Google Docs (66.23%), GoogleClass (22.08%), and MoodleCloud (28.57%), which reveals individuality and mobility in the use of resources for teaching and learning, promoting collaboration, communication and sharing of resources, as well as the implementation of the principle of personalized learning;
- 65.93% of respondents use digital tools based on neural technologies and artificial intelligence, in particular, 36.36% of respondents use GPT Chat to search and analyze text information, 10.39% use GPT resources to create presentations, 18.18% use AI-Bot for information visualization (6.49%) and infographic (11.69%). The array of information accumulated by chat bots allows you to visualize an idea of the best practices and work and apply this knowledge in training.

Fig. 4 shows respondents' digital tools for assessment (question 7). 68.83% of respondents use Google Forms, 32.47% use Chat Bot, 24.68% use Kahoot, and 18.18% use only computer-oriented programs.

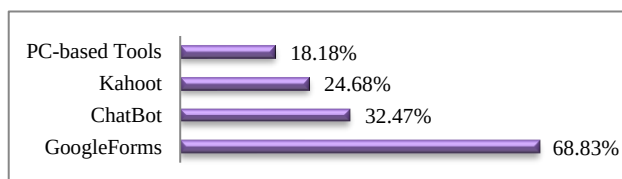


Fig. 4. Bar diagram of digital tools used by respondents for assessment.

Fig. 5 shows digital tools used for communication and collaboration (question 8). The data presented show that respondents use digital tools that allow them to organize various formats of communication and collaboration, among which, first of all, are webinars and web conferences based on ZOOM, Google Meet, which allow them to organize communication and collaboration in the “live virtually” format. 85.72% of respondents indicated that they use social networks and instant messengers, which allow organizing social learning – exchange of information and experience, collaboration, and joint creation of content between participants in the educational process using interactive discussions and discussions and social media.

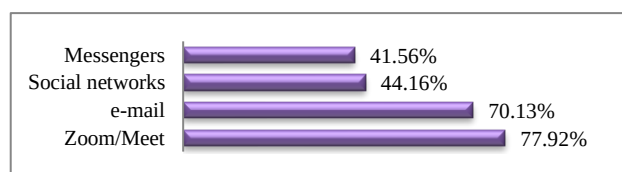


Fig. 5. Bar diagram of digital tools used by respondents for communication and collaboration.

Through social networks and instant messengers, respondents use metrics to evaluate the effectiveness of social learning, and SMM uses the following key criteria to monitor teaching and learning: frequency of access to

individual training materials, their popularity; the variety of types of user content and frequency of their addition; behavioral characteristics of students who share educational content; student activity in the online educational community; frequency of use of individual social media tools; surveys of satisfaction with training and surveys of mastery of educational material; connection with learning goals and individual goals of students.

Fig. 6 shows the tools used by respondents for gamification (question 9): 41.56% of respondents use LearningApps, 32.47% use WebQuests (respondents did not indicate the name of the applications), 22.08% use ClassCraft, and 2.6% do not use this tool.

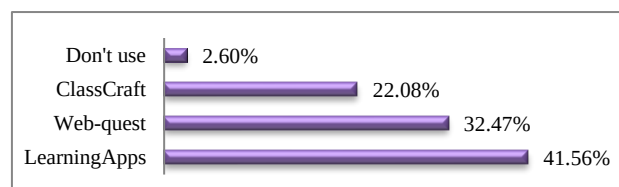


Fig. 6. Bar diagram of digital tools used by respondents for gamification.

Fig. 7 shows that 46.75% of the respondents would learn innovative technologies themselves and use them, 37.66% would use innovative technologies if they know about them helpful, 12.99% would use them if somebody teaches, and only 2.6% indicated that they would not use new technologies (question 10).

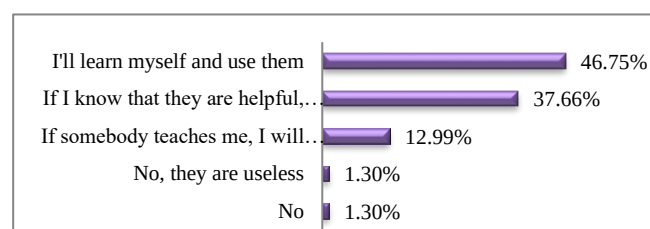


Fig. 7. Professional development bar diagram.

It should be noted that the respondents' answers do not include digital resources based on VR/AR, Big Data Analytics, and Digital Project Management. This result can be explained by the fact that the Republic of Uzbekistan is a developing country. The technical base in the country's Higher Education institutions has yet reach the level required for Education 4.0.

V. DISCUSSION

The main goal of this study was to indicate the digital tools that university professors use for the growth to Education 4.0 in the Republic of Uzbekistan.

Scientific studies were analyzed to achieve this goal, where trendy technologies and digital tools of Education 4.0 were revealed. The literature review showed that researchers illustrate teaching and learning in Education 4.0 as using interactive digital content founded on Cloud Computing and VR/AR, assessment smart tools based on Artificial Intelligence and Data Analytics, collaborative learning established on gamification and project management tools.

Based on this information, an online questionnaire was compiled, which made it possible to identify the digital tools used by professors at Uzbek Universities. Answers to the questions show that academic staff is actively using open resources based on digital communication and collaboration

tools, as well as cloud computing, both in teaching practice and in scientific research. This shows that Uzbek professors use open educational resources and cloud services. This result correlates with the results of the study [24], which has identified that teachers in Europe widely use open digital educational platforms and cloud services.

In addition, the analysis showed that more than half of teachers need motivation and practical help in learning and using new digital tools for teaching and learning.

It should be noted that although the number of responses is relatively small, they reflect a wide range of details from different regions, universities, departments, ages, and genders.

Based on the findings and discussion, the following recommendations are offered:

- 1) Create a repository where advanced digital tools will be collected through open software resources, websites, virtual laboratories, and simulators structured by various teaching activities.
- 2) Develop training to support academic staff in exploring new digital resources for Education 4.0.

VI. CONCLUSION

In conclusion, the transition towards Education 4.0 in Uzbek universities is marked by the increasing use of digital tools, although some challenges remain. This study has highlighted that while Uzbek University academic staff is incorporating open cloud-based tools and AI-based resources into the teaching process, there is a need for further motivation and practical support. The analysis of digital tools used by university professors in the Republic of Uzbekistan underscores the importance of developing a comprehensive repository of digital tools, including VR/AR and Big Data Analytics, to facilitate the transition to Education 4.0.

Moreover, it is essential to focus on continuous professional development programs that provide academic staff with the necessary skills and confidence to utilize new digital tools effectively. This accelerates the adoption of Education 4.0, ensuring a personalized, interactive, and flexible learning environment.

The findings and recommendations from this research provide a roadmap for all stakeholders to collaboratively enhance the digital infrastructure and capabilities of higher education institutions in developing countries.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Feruz Zakiyeva: questionnaire design, data analysis, results, discussion, and conclusion; Madina Zakiyeva: abstract, introduction, literature review, and data collection; both authors had approved the final version.

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